
Many evolutionary biologists are fascinated by the seemingly perfect fit of organisms to their environment. These persons presumably regard natural selection as the central and most important process of biological evolution, to the point that these two terms (“biological evolution” and “natural selection”) are often treated as synonymous, or interchangeable. It is a fact that, among the various processes contributing to biological evolution, natural selection has attracted the strongest interest, the sharpest controversies, and the vast majority of scientific studies.

There must be reasons for this, of which one is perhaps historical. To convince people that biological entities were not god-made creatures, Darwin and its followers had to simultaneously argue 1) that living forms change in time and 2) that their adaptations are sufficiently well explained by the process of natural selection. So, the two concepts have been and still are tightly associated in the context of anticereationist arguments. There might also be psychological reasons. Natural selection, unlike divine creation, is not an intuitive idea. Those who adopt it typically like it very much, and can hardly resist coming back to it again and again, finding the living world even more marvelous knowing that it was not generated by a creator. In a way, natural selection has somewhat replaced divine creation in many people’s minds as the process responsible for the beauty of nature.

The new book Mutation-Driven Evolution firmly opposes this view of natural selection as the unique biological creative force. This ambitious contribution is a vigorous reminder that the innumerable adaptive traits observable in the living world have all initially appeared as random, spontaneous, purposeless genetic changes, without which selection would be helpless. Prof. Nei argues that the biological evolutionary literature, both old and recent, puts too much emphasis on natural selection, and disregards the importance of mutation, which he here aims to rehabilitate as the major driver of biological evolution.

The main message of the book is delivered in the dense and thoughtful first three chapters. The author exposes his view of the history of concepts in population genetics and evolutionary biology during the past one and a half centuries. He recalls that Darwin defined natural selection as primarily purifying, and he criticizes Fisher’s “panselectionism” and Mayr/Dobzhansky’s comparisons of natural selection to an “artist” working with the “raw material” generated by mutation. Rather, Nei suggests that the classical NeoDarwinian models are too simplistic by typically assuming a constant selective...
pressure in space and time, and large amounts of pre-existing genetic variation. He argues that what matters in the first place in evolution is where and when a specific mutation will happen (or not).

This viewpoint is developed in the following six chapters, each of which treats a specific aspect of evolutionary biology to which the author has himself contributed at some point of his career—theoretical population genetics, molecular evolution, evo-devo, speciation, and adaptation.

Chapter 4 is about the neutral and nearly neutral theories of molecular evolution, and the influence of natural selection on protein evolution. Nei reviews early reports of the detection of positive selection at the molecular level (e.g., MHC, hemoglobin), and expresses doubts about more recent approaches, such as codon substitution models, the McDonald–Kreitman test, F_q-outlier methods, and haplotype-based methods, all of which he says are dependent on assumptions that are typically not verified in practice. The next chapter discusses the evolution of genome size, repeated elements and multigene families, emphasizing the author's favorite birth-and-death model—but no mention is made of Lynch's recent contribution to this topic. Chapter 6 addresses gene expression regulation and developmental evolution. It offers a compilation of remarkable case studies in which the genotype/phenotype link has been uncovered by molecular methods (such as hox genes in animals, eyeless in drosophila, stickleback pelvic fins, and sex determination in anmniotes. Regarding speciation, finally, it is argued in Chapter 7 that the Dobzhansky–Muller incompatibility model of the evolution of hybrid depression is not very well supported by empirical data. A number of alternative models are proposed—of which several could admittedly be called Dobzhansky–Muller sensu lato. The author favors the idea that incompatibilities between diverging populations are most often fixed by genetic drift rather than by local selection.

The final three chapters recapitulate the many ideas and arguments developed so far, and specifically address the issue of whether mutation or selection drives biological evolution and adaptation. This is perhaps the most disputable part of the whole book, in part because these two processes are probably not actually opposed, as acknowledged in the very first paragraph of Chapter 9. Actually, many of the examples taken as evidence for the predominance of mutation (such as the regressive evolution of cave fish eyes due to destructive mutations) might just as well be interpreted as reflecting instead the action of natural selection (such as relaxed functional requirements in the case of cave fish eyes). The author is obviously aware of this difficulty, but still vehemently defends his view that mutation is the leading force. He argues that natural selection is not a magic process able to solve every environmental challenge posed to living species—and this is demonstrated by the occurrence of species extinctions, in which the decisive factor is the ability for a declining species to find, or not, the appropriate rescue mutations before disappearing.

A bit frustratingly, no review is made of the literature on experimental evolution and its associated theories (e.g., based on Fisher's geometric model) even though several of the questions implicitly asked by the book have been, or might be, more or less directly addressed—for example, does mutation limit adaptation? Are there few or many mutational "solutions" to a given selective challenge? Standing variation versus new mutations; large effect versus small effect mutations. The variation in space and time of selection coefficients has also been widely discussed and modeled by ecological geneticists. This body of literature has already formalized some of the ideas introduced in this book, such as the "niche filling" and "constraint breaking evolution" concepts. For this reason it is unclear whether the arguments developed in the book actually deserve to be called a "new theory".

Among the numerous merits of *Mutation-Driven Evolution* is the survey that it makes of the author's impressive career, which started in the 1960s before the neutral theory of molecular evolution was conceived. Largely built upon the empirical and theoretical achievements of Nei's laboratory, this book brilliantly illustrates how molecular data have illuminated the Neodarwinian synthesis and affected evolutionary biology. *Mutation-Driven Evolution* is therefore not a "new theory", but rather a highly opinionated piece, in which the author intends to disseminate his own views on molecular and organismal evolution. Controversial opinions and provocative claims are not avoided regarding, for example, the definition of (near-)neutrality, the impact of organismal complexity on genome evolution, and the usage of statistical methods in sequence analysis; and the contributions of even the most famous scientists of our field are criticized without indulgence. A majority of readers, including this reviewer, will presumably disagree with many of these statements—and this perhaps makes the book even more enjoyable.

Overall, this is a fascinating piece of science and an impressive amount of work, thematically broad but still remarkably synthetic and focused in each of its sections. As a masters student I learned molecular evolution largely thanks to Nei's (1987) *Molecular Evolutionary Genetics*. I would warmly recommend this update to 21st century students, if only for its clarity and originality.

**REFERENCE**


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